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Performance Improvement of Solar Thermal Cooling Systems Integrated with Encapsulated PCM

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Abstract : Phase change materials (PCMs) have an important role in improving the efficiency of thermal heat storage. As these materials are characterized by low thermal conductivity, it is necessary to develop heat transfer techniques to improve their thermophysical properties. This scientific article focuses on the geometrical configurations of encapsulated PCM containers and the impact of designs to improve the performance of the solar thermal cooling system. The literature review showed that in-depth research is being conducted on different methods of improving the efficiency of PCM heat transfer, which is the main design task for the containers. Techniques such as microencapsulated PCMs, adding fins and different combinations of fins and nanoparticles are used. The use of graphite, metal foam and doping of high photothermal materials is also being studied. To determine most efficient container configuration, the article looks at different designs of PCM containers with fins for the storage tank. This paper experimentally investigates the effect of the encapsulation design on the performance of a lab-scale thermal energy storage tank. The development of optimized energy storage with integrated phase change material containers reduces auxiliary heater energy consumption, increases the COP of the solar cooling system, and reduces the environmental impact of the cooling system. The review shows that in the cylindrical construction, the ratio between the radius of shell and tube is significant, which means this ratio is the main issue to enhance transfer efficiency and to increase the value of stored heat. Therefore, three cylindrical tube containers with different radiuses 20mm, 35mm, 50mm filled with commercial phase change material were tested. The results show that using a smaller radius achieved a higher power, leading to a reduction in the charging and discharging time. The three fins were added to the selected cylindrical tube to determine their effects on heat exchanging efficiency. The observed optimized performance given by the fin’s arrangement achieved a 40% reduction of PCM's melting time compared to the heat exchanging without fins. The exact dimensions of the PCM containers and fins placements will be presented on-site.

Keywords : energy performance, PCM containers, solar thermal cooling, storage tank
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